Update of the standardized CPUE of the albacore caught by Japanese longline fishery in the Indian Ocean.

Koji Uosaki

National Research Institute of Far Seas Fisheries
7-1, Orido 5-chome, Shimizu-shi, 424-8633 Japan

1. INTRODUCTION

The albacore in the Indian Ocean has exploited since the early 1950s. The albacore catch increased to about 40,000 t in 1998 at the historical highest level, though the range of the catch had been from 10,000 t to 30,000 t during the period from the 1960s to the mid 1990s. Japanese longline fishery commenced in this Ocean since early 1952. The fishery caught albacore ranging from 9,000 to 18,000 t in the 1960s that corresponds to the beginning of the long history of the fishery. Since then the catch decreased rapidly and reached 900 t in 1978. This drastic change is due to the change of target species of the longline fishery, i.e., yellow fin tuna and albacore to southern bluefin tuna and bigeye tuna, during the 1970s. The catch continues to be a low level ranging from 200 t to 2,500 t.

For the Indian albacore caught by Japanese longline fishery, the CPUE standardization using the General Linear Model (GLM) with the assumption that the error structure belongs to log-normal had been carried out (Uozumi 1994) for 1960-1991. In this document, the standardized CPUE for the Indian albacore was simply updated to monitor the trend of the abundance of this stock using basically the same model as Uozumi (1994).

2.MATERIALS AND METHODS

2.1. Data

The data used here is the logbook data that has been compiled at National Research Institute of Far Seas Fisheries (NRIFSF) based on the logbook mandatory submitted by the fishermen of the longline vessel larger than 20 gross ton (GRT). The data is aggregated by month, 5˚x5˚ block, and number of hooks per basket (HPB), for 1975-2002. The data in 2002 is still preliminary. CPUE was defined as the number of fish caught per 1,000 hooks. Observations with less than 5,000 hooks were excluded from this analysis.

2.2. Standardization

In order to standardize CPUE of albacore, a GLM assuming log-normal error structure was used. The model used is the almost same model to that used in Uozumi (1994). This model included main effects of year, season, subarea and gear configuration. Quarter was used for fishing season categorized to eight levels. The subarea was categorized to four levels (Fig. 1) and the gear configuration were categorized to four levels (4-7, 8-11, 12-15 and 16-21 HPB). Becasue the information of gear configration was not available for 1960-1974, each observation was regarded as the 4-7 HPB. The classification of subarea was defined based on the spatial distribution patterns of nominal CPUE of albacore and of species composition of longline catch. This stratification was modified from Uozumi (1994). In order to include observations with no catch of albacore, a constant were added to the CPUE. The constant 0.4 were used as 10% of mean CPUE. The model used was:

$\ln(CPUE+C) = \mu + Y_i + Q_j + A_k + G_l + Q*A_{jk} + Q*G_{jl} + e_{ijkl}$

where μ: intercept C : constant

Y_i: effect of year in year i Q_j: effect of quarter in quarter j

A_k: effect of subarea in in area k G_l: effect of gear in gear l

$Q*A_{jk}$: interaction term between quarter and area in quarter j and area k

$Q*G_{jl}$: interaction term between quarter and gear in quarter j and gear l

e_{ijkl} : error term

Standardized CPUE was calculated as follows:

$\text{Standardized CPUE}_i = \text{EXP}(\text{LSM}(Y_i) + \text{MSE}/2) - C$

where $\text{LSM}(Y_i)$: least square mean of year effect in year i

MSE: Mean square error

3. RESULT AND DISCUSSION

The analysis of variance for the GLM analysis is shown in Tables 1. This shows all the effects significant with 0.1 % level. The distribution of standardized residual indicated not to be largely unbiased as shown in Fig. 2 and Fig. 3. The standardized CPUE was high at about 10 fish/1000hooks for 1960-1965 (Fig. 4), and then, rapidly decreased to about 2 fish/1000hooks, 20 % of the level during the 1965-1978 period. Since then the CPUE became stable at the level in the view of whole time series analyzed, more in detail, the CPUE showed no clear trend during the 1980s though 2002 period.

Uosaki (2004) demonstrated that since the late 1960s, Japanese longline fishery has been run without targeting albacore, and that the fishing effort has not deployed in the region where albacore is abundant, though a part of the longline fleet had primarily caught albacore in the 1960s. From this situation the standardized CPUE obtained here may not reflect the abundance of albacore in the Indian Ocean. At least after 1975 Japanese longline has caught albacore only in the geographically margin of the region where albacore abundantly distributed, as pointed out by Uozumi (1994).

The standardized CPUE using the data only from Area 2 and Area 4 (modified model), where albacore is generally abundant, was shown in Fig. 5 just for comparison to that shown above (reference model). This indicated that the CPUE for the modified model showed the similar trend to that for the reference model, and that the standardized CPUE even in the abundant region was low as well as in the other region. This suggest that the longline fishery operated without targeting albacore even in the region.

REFERENCE

Uozumi, Y. 1994: The CPUE trend for albacore in Indian Ocean waters caught by the Japanese longline fishery. Proceeding of 5th Expert Consultation on Indian Ocean tunas. IPTP Col. Vol. 8. 147-149.

Uosaki, K. 2004: Brief review of Japanese longline fishery and its albacore catch in the Indian Ocean. IOTC-WPTMP-2004-XX.

Table 1. Analysis of variance for the GLM analysis.

Source	DF	SS	Mean Sq.	F Value	Pr > F
Model	85	32684.88	384.528	389.03	0.0001
Error	41858	41373.89	0.988		
Corr. Tot.	41943	74058			

R-square= 0.441 C.V.= 356.5

Source	DF	Type III SS	Mean Sq.	F Value	Pr > F
Y	42	5985.82	142.52	144.19	<.0001
Q	3	420.53	140.18	141.82	<.0001
A	7	16436.96	2348.14	2375.61	<.0001
G	3	291.78	97.26	98.40	<.0001
Q*A	21	1635.66	77.89	78.80	<.0001
Q*G	9	78.16	8.68	8.79	<.0001

Table 2. Standardized CPUE (number of fish/hooks) with the 95% confidence intervals.

Year	Mean	Lower 95% limit	Upper 95% limit
1960	10.198	9.201	11.298
1961	10.606	9.533	11.794
1962	10.625	9.732	11.596
1963	8.982	8.188	9.850
1964	11.678	10.693	12.750
1965	7.596	6.963	8.284
1966	6.304	5.796	6.853
1967	6.330	5.869	6.824
1968	5.461	5.048	5.905
1969	4.879	4.514	5.270
1970	4.167	3.823	4.539
1971	3.327	3.045	3.632
1972	3.106	2.781	3.464
1973	3.021	2.718	3.352
1974	3.130	2.846	3.439
1975	2.043	1.872	2.227
1976	2.854	2.574	3.161
1977	1.888	1.686	2.109
1978	1.454	1.323	1.594
1979	1.581	1.425	1.749
1980	1.744	1.587	1.913
1981	1.927	1.770	2.095
1982	1.975	1.818	2.144
1983	2.010	1.859	2.172
1984	2.005	1.855	2.166
1985	2.109	1.956	2.272
1986	2.397	2.230	2.574
1987	2.538	2.352	2.735
1988	1.734	1.591	1.887
1989	1.673	1.519	1.839
1990	1.775	1.613	1.949
1991	1.270	1.158	1.391
1992	1.503	1.371	1.646
1993	1.565	1.432	1.707
1994	1.352	1.264	1.445
1995	1.229	1.154	1.308
1996	1.251	1.179	1.327
1997	1.547	1.462	1.635
1998	1.716	1.623	1.814
1999	1.349	1.268	1.435
2000	1.418	1.331	1.510
2001	1.451	1.362	1.544
2002	1.595	1.498	1.698

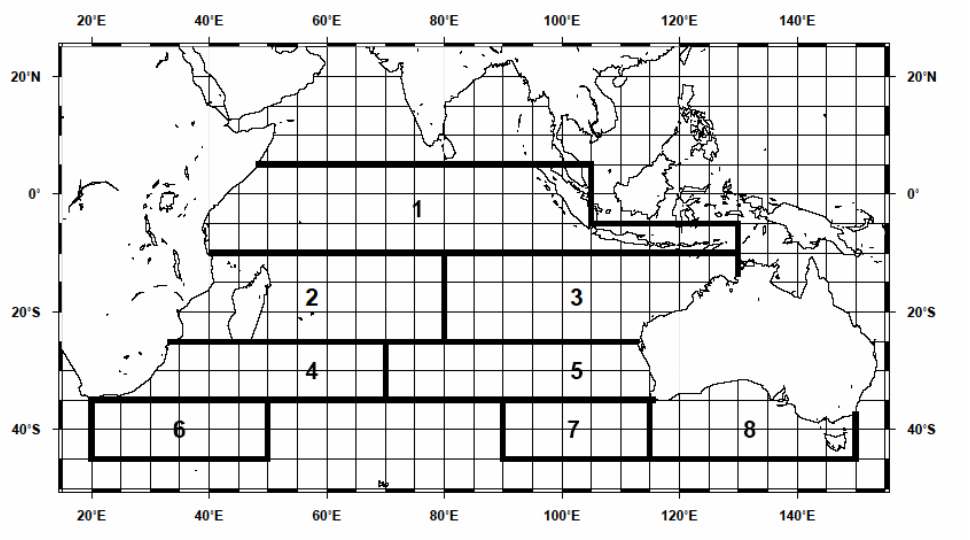

Fig. 1. Subarea used for the GLM analysis.

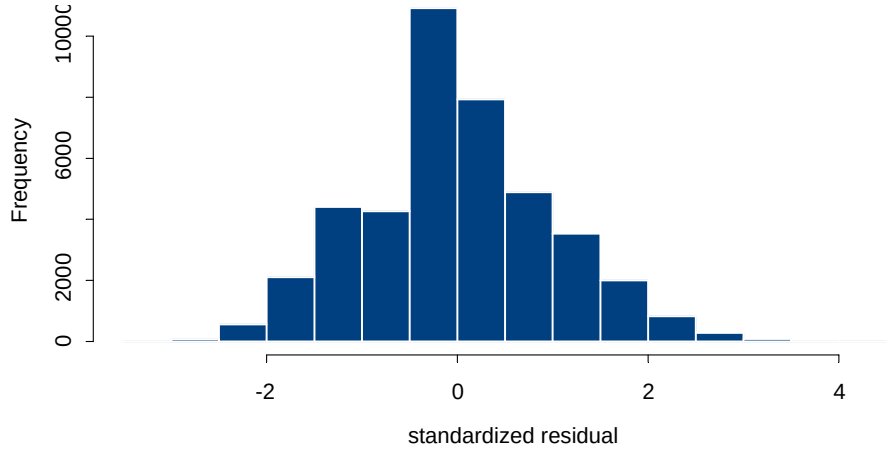

Fig. 2. Distribution of the standardized residual for the GLM analysis.

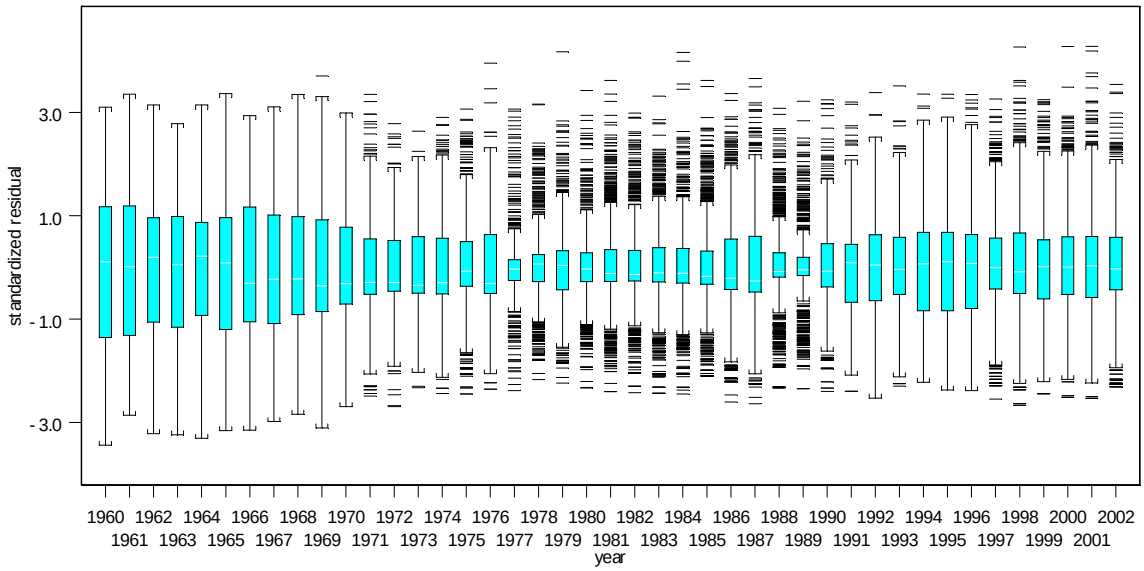

Fig. 3. Box plot of the standardized residual by year for the GLM analysis.

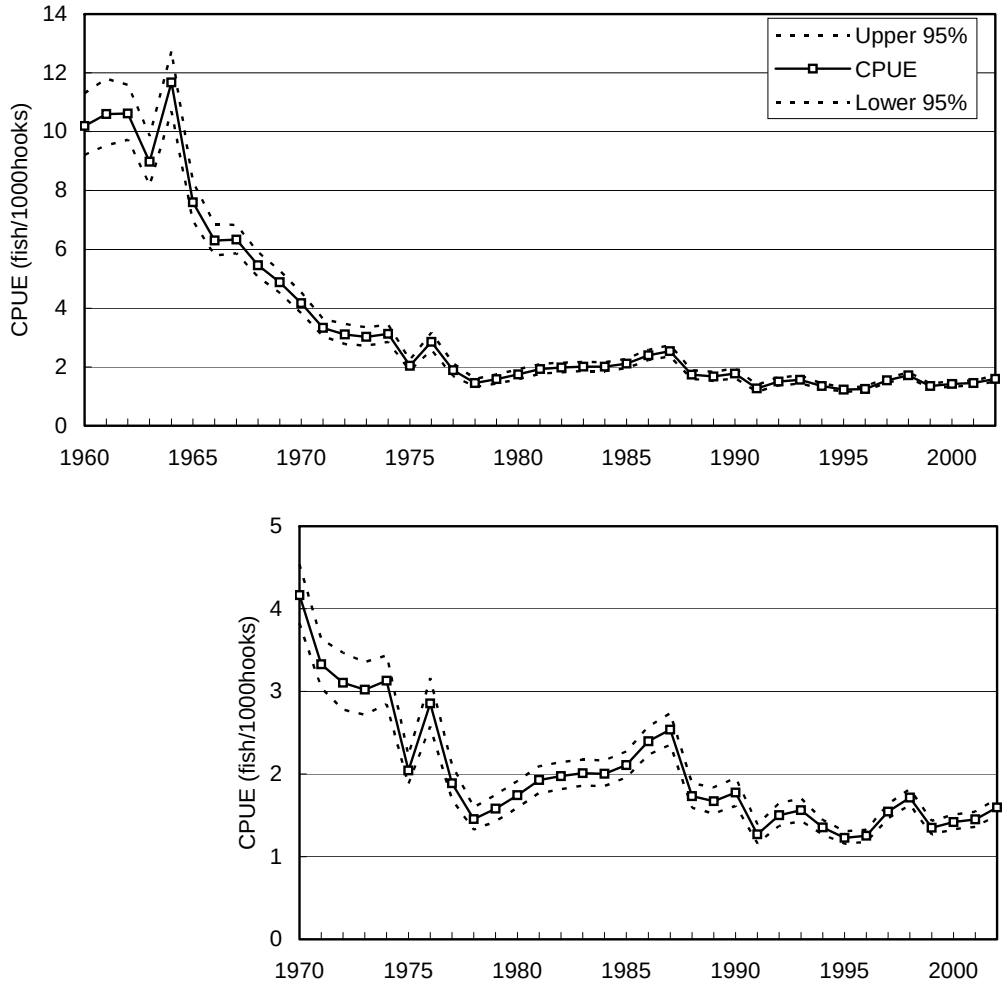

Fig. 4. Standardized CPUE for the albacore in the Indian Ocean. The bottom panel is changed on the scale from top panel and is shown only for 1970-2002.

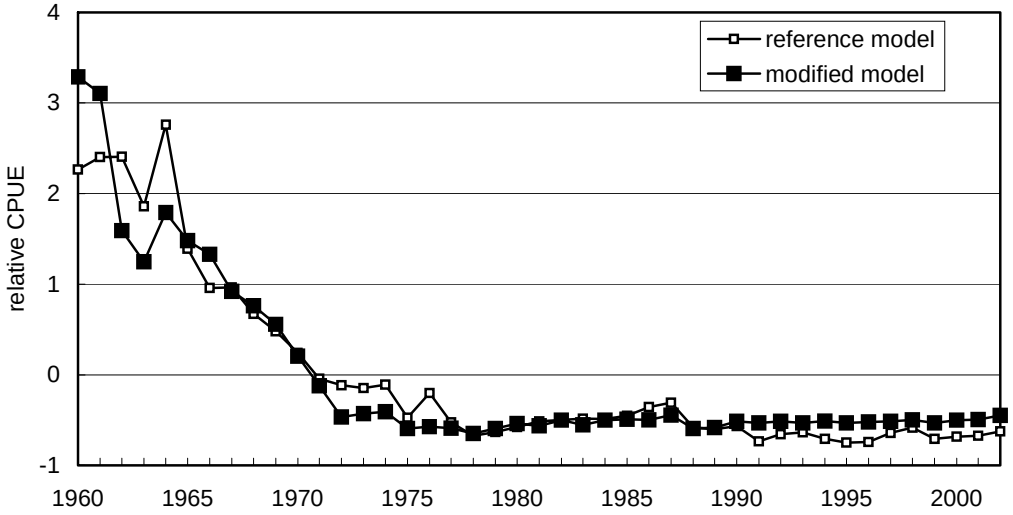

Fig. 5. Standardized CPUEs for the reference and modified models. The CPUE for the modefied model were calculated using only from Area 2 and Area 4 where albacore is generally abundant. The CPUE for the reference model is the same one to that shown in Fig.4. Both CPUEs were adjusted with taking difference to mean and dividing standard deviation.